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- REMARKS / ARGUMENTS -

Claims 1 to 10, 12 to 17 and 19 to 22 remain in the present application.

Summary

The bases for the present claim rejections can be generally paraphrased as alleging that it would be obvious to combine a known tip clearance techniques with techniques known to intermittently control fuel flow. Applicant submits that the design considerations affecting each subject area (tip clearance and fuel flow) are different enough that the alleged link between prior art references is not supportable. Tip clearance control is highly refined art, wherein only a few thousandths of an inch exist between two completely unacceptable boundary conditions - tip rub (mechanical damage) and too much tip clearance (inefficient turbine cycle). Pulse width modulation involves switching in a binary manner quickly between to extreme positions (e.g. on-off). **The skilled person would understand applying PWM to tip control means oscillating between not enough clearance (tip rub, mechanical damage), and too much clearance (inefficient turbine cycle) - i.e. based on good tip clearance design principles, PWM should provide a device that does not work, and therefore is not an obvious design choice at all.** In other words, the sensitivity of the art makes general allegations of obviousness of this type inapplicable, and not within what would actually be taught to those appreciating the full scope of the design problem presented in tip clearance control. This will now be discussed in more detail.

Discussion

Rejection of claims 1-22 under 35 USC §103(a) using Redinger (4,069,662) or Wilson et al. (6,925,814) or Franconi et al (5,910,851) or JP 58-214603, in view of any of Falk (3,421,318), McArthur (6,209,309), and Nystrom (3,999,388)

and

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Double Patenting on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-7 of Wilson et al. (6,925,814) in view of any of Falk (3,421,318), McArthur (6,209,309), and Nystrom (3,999,388) and optionally further in view of Redinger (4,069,662)

As stated in MPEP section 2142, to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Contrary to what is suggested in the Office Action, the Applicant believes that the foregoing test for obviousness is not met. There is no motivation nor suggestion in the cited references or in the knowledge available to a person skilled in the art to modify the references or to combine the reference teachings. Furthermore, the teaching or suggestion to make the claimed combination and the reasonable expectation of success are not found in the prior art. These issues are argued in more detail below.

From the Office Action (OA), the Applicant understands that neither Redinger nor Pellow nor Franconi nor JP 58-214603 nor Wilson (referred to herein as the "primary references") teach using **pulse width modulation** in the context of controlling a clearance gap between a rotor blade tip and a surrounding structure in a gas turbine engine. For example, the OA states: "Redinger [...] does not specifically teach a PWM valve."

The OA states that either one of Falk (3,421,318), McArthur (6,209,309), and Nystrom (3,999,388) (referred to herein as the "secondary references") discloses pulse width modulation (PWM) and that it *would have been obvious to one of ordinary skill in the art*

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to employ a PWM valve with a cycle for the on-off control of the clearance control air, due to its low costs and/or flow modulating abilities and/or precise metering abilities.

The Applicant disagrees that it would have been obvious to a person skilled in the art combine the teachings of either one of the primary references with the teachings of either one of the secondary references and the combinations of which would result in the claimed invention. More specifically, the present paper will show that it is not obvious to a person skilled in the art to combine "A turbine cooling system [or method] used in a gas turbine engine for controlling tip clearance between a turbine shroud assembly and turbine rotor blades" (from abstract of Wilson) with the use of PWM disclosed in any of the secondary references and that, in any case, the combination of the cited references would not result in the claimed invention.

First off, the subject matter of the secondary references must be clearly identified.

Concerning Falk the OA states, at pages 3, 5, 7, 8 and 9 of the OA, that it "teaches modulating flows with a PWM valve with a duty cycle (col. 1, lines 11+) is old and well known in the art." The OA omits to mention that the **only** flows which are described in Falk are **fuel flows** and not cooling air directed to a turbine shroud area for controlling a gap between a rotor blade tip and the turbine shroud.

Concerning McArthur the OA states, at pages 3, 5, 7, 8 and 9 of the OA, that it "teaches using a PWM valve with a duty cycle is well known for its metering ability and low costs." Again, the OA omits to mention that McArthur **only** discusses the control of fluid flow rate (more specifically fuel flow) from a pump. It never mentions the possibility of using PWM in the context of controlling cooling air directed to a turbine shroud area for controlling a gap between a rotor blade tip and the turbine shroud, or the problems associated therewith.

Concerning Nystrom the OA states, at pages 3, 5, 7, 8 and 9 of the OA, that it "teaches using a PWM with a duty cycle solenoid controlled valve 37 to modulate gas flow is old

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and well known in the art.” Again, the OA omits to mention the complete context of the reference. Nystrom describes (at column 1, lines 30-31) “[producing PWM] signals to solenoid valves [i.e., a solenoid valve arrangement] which control the supply of **working gas** to the [piston] engine [from a hydrogen or helium reservoir], the withdrawal of working gas from the engine and establishing of direct connection between the spaces in the engine separated by its pistons.” (emphasis added) None of this concerns, or hints toward, controlling cooling air directed to a turbine shroud area for controlling a gap between a rotor blade tip and the turbine shroud.

Clearly, the OA does not show that the secondary references teach, or suggest to modify the prior art references, to apply PWM to control cooling air directed to a turbine shroud area for controlling a gap between a rotor blade tip and the turbine shroud. Hence the first criteria to establish a *prima facie* case of obviousness is not met. This will be further discussed below.

In the course of coming up with the present invention, the Applicant was faced with the problem of increasing gas turbine engine efficiency by controlling the cooling air directed to a turbine shroud area for controlling a gap between a rotor blade tip and the turbine shroud. The Applicant was faced with the state of the art which is illustrated by Redinger; that is, “the on/off or modulating type of cool air control means may operate as a function of the gap between the outer air seal and tip of the turbine, such a control would be **highly sophisticated and introduce complexity.**” (emphasis added) (col. 2, lines 34-41). This statement alone is sufficient to show that a person skilled in the art would be discouraged from attempting to simplify the system taught by Redinger by using a modulated signal; i.e., that the prior art of the primary references teaches away from the present invention and hence that the second criteria of reasonable expectation of success is also not met.

The Applicant submits that the solution did not simply involve the application of a PWM control scheme to a valve. The solution involved the discovery that turbine shroud response would be slow enough to give good averaging from a tip clearance

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point of view. This is clearly described in paragraph [0027] of the present application which states "the turbine shroud area 402 thermal response is slow enough such that the valve 60 may have a reasonably slow duty cycle (a few seconds on, a few seconds off), and this does not require very rapid response rates nor require significant cyclic variations during engine performance." In other words, the present invention is based on a recognition not present or taught in the prior art. The secondary references, which while they discuss the use of PWM, they do not consider or discuss the problems associated with applying PWM to control cooling air directed to a turbine shroud area for controlling a gap between a rotor blade tip and the turbine shroud. Again, this points to the fact that the first criteria to establish a *prima facie* case of obviousness is not met.

Finally, the third criteria to establish a *prima facie* case of obviousness is not met either; that is, the combination of the prior art references do not teach all the claim limitations. As discussed above, the prior art does not teach **controlling a first portion of cooling air admitted directly to said turbine shroud area by adjusting a duty cycle of a modulating signal (comprising a pulse width modulation signal)** according to a cooling air requirement and diverting a second portion of said cooling air to other components of the gas turbine engine.

Recapping, 1- none of the secondary references teach or suggest the use of PWM to control cooling air directed to a turbine shroud area for controlling a gap between a rotor blade tip and the turbine shroud; 2- none of the references discuss how to resolve the problems associated with the use of PWM to control cooling air directed to a turbine shroud area for controlling a gap between a rotor blade tip and the turbine shroud; 3- the prior art teaches away from the claimed invention; and 4- the prior art references do not teach all the claim limitations. None of the criteria for establishing obviousness are met.

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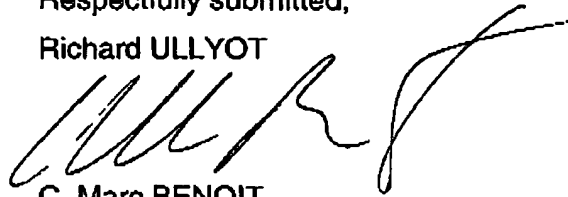
The Applicant therefore believes that the claims are not obvious in view of cited prior art. In view of the foregoing, reconsideration of the claim rejections is respectfully requested.

It is believed that claims 1 to 10, 12 to 17 and 19 to 22 are allowable over the prior art, and a Notice of Allowance is earnestly solicited.

Respectfully submitted,

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